## **UNIT TERMINAL OBJECTIVE**

8-4 At the completion of this unit, the paramedic student will be able to evaluate hazardous materials emergencies, call for appropriate resources, and work in the cold zone.

## **COGNITIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 8-4.1 Explain the role of the paramedic/ EMS responder in terms of the following: (C-1)
  - a. Incident size-up
  - b. Assessment of toxicologic risk
  - c. Appropriate decontamination methods
  - d. Treatment of semi-decontaminated patients
  - e. Transportation of semi-decontaminated patients
- 8-4.2 Size-up a hazardous materials (haz-mat) incident and determine the following: (C-1)
  - a. Potential hazards to the rescuers, public and environment
  - b. Potential risk of primary contamination to patients
  - c. Potential risk of secondary contamination to rescuers
- 8-4.3 Identify resources for substance identification, decontamination and treatment information including the following: (C-1)
  - a. Poison control center
  - b. Medical control
  - c. Material safety data sheets (MSDS)
  - d. Reference textbooks
  - e. Computer databases (CAMEO)
  - f. CHEMTREC
  - g. Technical specialists
  - h. Agency for toxic substances and disease registry
- 8-4.4 Explain the following terms/ concepts: (C-1)
  - a. Primary contamination risk
  - b. Secondary contamination risk
- 8-4.5 List and describe the following routes of exposure: (C-1)
  - a. Topical
  - b. Respiratory
  - c. Gastrointestinal
  - d. Parenteral
- 8-4.6 Explain the following toxicologic principles: (C-1)
  - a. Acute and delayed toxicity
  - b. Route of exposure
  - c. Local versus systemic effects
  - d. Dose response
  - e. Syneraistic effects
- 8-4.7 Explain how the substance and route of contamination alters triage and decontamination methods. (C-1)
- 8-4.8 Explain the limitations of field decontamination procedures. (C-1)
- 8-4.9 Explain the use and limitations of personal protective equipment (PPE) in hazardous material situations. (C-
- 8-4.10 List and explain the common signs, symptoms and treatment for the following substances: (C-1)
  - a. Corrosives (acids/ alkalis)
  - b. Pulmonary irritants (ammonia/ chlorine)
  - c. Pesticides (carbamates/ organophosphates)
  - d. Chemical asphyxiants (cyanide/ carbon monoxide)

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- e. Hydrocarbon solvents (xylene, methlyene chloride)
- 8-4.11 Explain the potential risk associated with invasive procedures performed on contaminated patients. (C-1)
- 8-4.12 Given a contaminated patient determine the level of decontamination necessary and : (C-1)
  - Level of rescuer PPE
  - b. Decontamination methods
  - c. Treatment
  - d. Transportation and patient isolation techniques
- 8-4.13 Identify local facilities and resources capable of treating patients exposed to hazardous materials. (C-1)
- 8-4.14 Determine the hazards present to the patient and paramedic given an incident involving hazardous materials. (C-2)
- 8-4.15 Define the following and explain their importance to the risk assessment process: (C-1)
  - a. Boiling point
  - b. Flammable/ explosive limits
  - c. Flash point
  - d. Ignition temperature
  - e. Specific gravity
  - f. Vapor density
  - g. Vapor pressure
  - h. Water solubility
  - i. Alpha radiation
  - j. Beta radiation
  - k. Gamma radiation
- 8-4.16 Define the toxicologic terms and their use in the risk assessment process: (C-1)
  - a. Threshold limit value (TLV)
  - b. Lethal concentration and doses (LD)
  - c. Parts per million/ billion (ppm/ ppb)
  - d. Immediately dangerous to life and health (IDLH)
  - e. Permissible exposure limit (PEL)
  - f. Short term exposure limit (TLV-STEL)
  - Ceiling level (TLV-C)
- 8-4.17 Given a specific hazardous material be able to do the following: (C-1)
  - a. Research the appropriate information about it's physical and chemical characteristics and hazards
  - b. Suggest the appropriate medical response
  - c. Determine risk of secondary contamination
- 8-4.18 Determine the factors which determine where and when to treat a patient to include: (C-1)
  - a. Substance toxicity
  - b. Patient condition
  - c. Availability of decontamination
- 8-4.19 Determine the appropriate level of PPE to include: (C-1)
  - a. Types, application, use and limitations
  - b. Use of chemical compatibility chart
- 8-4.20 Explain decontamination procedures when functioning in the following modes: (C-1)
  - a. Critical patient rapid two step decontamination process
  - b. Non-critical patient eight step decontamination process
- 8-4.21 Explain specific decontamination procedures. (C-1)
- 8-4.22 Explain the four most common decontamination solutions used to include: (C-1)
  - a. Water
  - b. Water and tincture of green soap
  - c. Isopropyl alcohol
  - d. Vegetable oil

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- 8-4.23 Identify the areas of the body difficult to decontaminate to include: (C-1)
  - a. Scalp/ hair
  - b. Ears/ ear canals/ nostrils
  - c. Axilla
  - d. Finger nails
  - e. Navel
  - f. Groin/ buttocks/ genitalia
  - g. Behind knees
  - h. Between toes, toe nails
- 8-4.24 Explain the medical monitoring procedures of hazardous material team members to be used both pre and post entry, to include: (C-1)
  - a. Vital signs
  - b. Body weight
  - c. General health
  - d. Neurologic status
  - e. ECG
- 8-4.25 Explain the factors which influence the heat stress of hazardous material team personnel to include: (C-1)
  - a. Hydration
  - b. Physical fitness
  - c. Ambient temperature
  - d. Activity
  - e. Level of PPE
  - f. Duration of activity
- 8-4.26 Explain the documentation necessary for Haz-Mat medical monitoring and rehabilitation operations. (C-1)
  - a. The substance
  - b. The toxicity and danger of secondary contamination
  - c. Appropriate PPE and suit breakthrough time
  - d. Appropriate level of decontamination
  - e. Appropriate antidote and medical treatment
  - . Transportation method
- 8-4.27 Given a simulated hazardous substance, use reference material to determine the appropriate actions. (C-3)
- 8-4.28 Integrate the principles and practices of hazardous materials response in an effective manner to prevent and limit contamination, morbidity, and mortality

## **AFFECTIVE OBJECTIVES**

None identified for this unit.

## **PSYCHOMOTOR OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 8-4.29 Demonstrate the donning and doffing of appropriate PPE. (P-1)
- 8-4.30 Set up and demonstrate an emergency two step decontamination process. (P-1)
- 8-4.31 Set up and demonstrate an eight step decontamination process. (P-1)

#### **DECLARATIVE**

- I. Role of paramedic in hazardous materials response
  - A. Incident size-up
    - Recognition that incident involves hazardous materials
      - a. Transportation incidents
      - b. Highway crashes
      - c. Storage of materials
      - d. Manufacturing operations
      - e. Acts of terrorism
    - 2. Use of the following to identify the substance
      - a. Department of Transportation (DOT) emergency response guide
      - b. United Nations (UN) numbers
      - c. National Fire Protection Agency (NFPA) 704 placard system
      - d. DOT placards
      - e. Shipping papers
      - f. Material safety data sheets (MSDS)
    - 3. Immediate need for evacuation or other action
    - 4. Immediate action with ambulatory patients
    - 5. Determine zones
      - a. Hot zone dangerous area
      - b. Warm zone entry/ decontamination point
      - c. Cold zone safe area
  - B. Assessment of toxicologic risk
    - 1. Determine type of chemical
    - 2. Actions of chemical
    - 3. Potential for secondary contamination
    - 4. Out-of-hospital medical treatment
  - C. Appropriate decontamination methods
    - 1. Techniques to decontaminate patients
    - 2. Recognition that no patient is completely decontaminated
  - D. Treatment of semi-decontaminated patients
    - Appropriate use of PPE
  - E. Transportation of semi-decontaminated patients
    - 1. Methods to prevent vehicle contamination
  - F. NFPA levels of response
    - 1. All personnel who may arrive first must be trained to an awareness level
    - 2. Paramedics who may transport "semi-decontaminated patients" be trained to the NFPA 473 "I evel-1"
    - 3. Paramedics who may have to rapidly "decon" and assist in the decontamination corridor be trained to the 473 "Level-2"
  - G. Monitoring of hazardous materials personnel
- II. Hazardous materials size-up
  - A. High degree of awareness
    - Vehicle crashes
      - a. Commercial vehicles
      - b. Pest control vehicles
      - c. Tankers
      - d. Cars with alternative fuels

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- e. Tractor-trailers
- 2. Transportation
  - a. Railroads
  - b. Pipelines
- 3. Storage
  - a. Tanks/ storage vessels
  - b. Warehouses
  - c. Hardware/ agricultural stores
  - d. Agriculture
- 4. Manufacturing operations
  - a. Chemical plants
  - b. All manufacturing operations
- 5. Terrorism
  - a. Workplace
  - b. Shopping
  - c. Other public environments
- B. Recognition of hazard
  - Placarding of vehicles
    - a. Required by law
    - b. Some vehicles not placarded
    - c. Placarding in emergency response guide
  - 2. UN/ DOT placard classifications
    - a. Explosives
    - b. Gasses
    - c. Flammable liquids
    - d. Flammable solids
    - e. Oxidizers and organic peroxides
    - f. Poisonous and etiologic agents
    - g. Radioactive materials
    - h. Corrosives
    - i. Miscellaneous hazardous materials
  - 3. Recognition of UN numbers
  - 4. NFPA 704 System for fixed facilities
    - a. Blue = health hazard
    - b. Red = fire hazard
    - c. Yellow = reactivity hazard
- C. Identification of substances
  - 1. The "crux" of dealing with a hazardous material
  - 2. Often difficult-especially with unknown substances
  - 3. Material safety data sheets (MSDS)
    - a. Detailed substance information
  - 4. Shipping papers
    - a. Substance ID
  - 5. DOT Emergency Response Guide
    - a. UN numbers
    - b. Names of substances
    - c. Emergency action guide
    - d. Placard facsimiles
    - e. Evacuation/ isolation information
  - 6. Poison control centers

- a. Detailed toxicology information
- b. Decontamination methods
- c. Treatment
- 7. CAMEO computer database
  - a. Information
  - b. Computer modeling
- 8. CHEMTREC
  - a. 24 hour toll free hotline
  - b. Product and emergency action information
- 9. Other reference sources
  - a. Textbooks
  - b. Handbooks
  - c. Technical specialists
- 10. Monitors and testing for unknown materials
  - a. Air monitoring equipment
  - b. Gas monitoring equipment
  - c. Ph testing
  - d. Chemical testing
  - e. Colormetric tube testing
- D. Hazardous material zones
  - 1. Hot zone
    - a. Contamination actually present
    - b. Site of incident
    - c. Entry with high level PPE
    - d. Entry limited
  - 2. Warm zone
    - a. Buffer zone outside of hot zone
    - b. Where decontamination corridor is located
    - c. Corridor has "hot" and "cold" end
  - Cold zone
    - a. Safe area
    - b. Staging for personnel and equipment
    - c. Where medical monitoring occurs
    - d. One end of corridor
- E. Specific terminology for medical hazardous materials operations
  - 1. Boiling point
  - 2. Flammable/ explosive limits
  - 3. Flash point
  - 4. Ignition temperature
  - 5. Specific gravity
  - 6. Vapor density
  - 7. Vapor pressure
  - 8. Water solubility
  - 9. Alpha radiation
  - 10. Beta radiation
  - 11. Gamma radiation
- F. Specific toxicologic terms and their use in the risk assessment process
  - 1. Threshold limit value (TLV)
  - 2. Lethal concentration and doses (LD)
  - 3. Parts per million/billion (ppm/ppb)

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- 4. Immediately dangerous to life and health (IDLH)
- 5. Permissible exposure limit (PEL)
- 6. Short term exposure limit (TLV-STEL)
- 7. Ceiling level (TLV-C)

# III. Contamination and toxicology review

- A. Types of contamination
  - 1. Primary contamination
    - a. Exposure to substance
    - b. Only harmful to individual
    - c. Little chance of exposure to others
  - 2. Secondary contamination
    - a. Exposure to substance
    - b. Substance easily transferred
    - c. Touching patient results in contamination
    - d. Key concept in hazardous materials medical operations
    - e. Gas exposure rarely results in secondary contamination
    - f. Liquid and particulate matter more likely to result in secondary contamination
- B. How poisons are absorbed
  - Topical absorption
    - a. Skin and mucous membranes
    - b. Not all skin absorbs at same rate
    - c. Not all poisons easily absorbed
  - 2. Respiratory inhalation
    - a. Absorption through bronchial tree
    - b. Oxygen deficient atmospheres
  - 3. Gastrointestinal ingestion
    - a. Ingestion of substances
    - b. Factors affecting absorption
  - 4. Parenteral injection
    - a. Injection
    - b. Wound entry
    - c. Invasive medical procedures
- C. Cycle of poison actions
  - Absorption
    - a. Time to delivery into blood stream
  - 2. Distribution
    - a. Distribution to target organs
    - b. Poison or drug binds to tissues/ molecules
    - c. Actions
    - d. Deposits
  - 3. Biotransformation
    - a. Liver
  - 4. Elimination
    - a. GI
    - b. Kidney
    - c. Respiratory
- D. Poison actions
  - 1. Acute toxicity
    - Immediate effect from substance

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- 2. Delayed toxicity
  - a. No immediate effect
  - b. Symptoms later appear
  - c. Delayed pathology or disease
- Local effects
  - a. Effect immediate site
  - b. Burn model
  - c. Progression of effects like burn
  - d. Topical or respiratory
  - e. Skin irritation acute bronchospasm
- 4. Systemic effects
  - a. Cardiovascular
  - b. Neurologic
  - c. Hepatic
  - d. Renal
- 5. Dose response
  - a. Physiologic response to dosage
  - b. How much to get an effect
  - c. Essential concept for decontamination
- 6. Synergistic effects
  - a. Combinations may react synergistically
  - b. Standard pharmacologic approach
  - c. Standard treatment can result in synergy
  - d. Medical control/ poison control reference
- E. Treatment for commonly encountered hazardous materials
  - Corrosives (acids/ alkalis)
    - a. Typical exposures
    - b. Actions
    - c. Decontamination methods
    - d. Treatment
    - e. Transportation precautions
  - 2. Pulmonary irritants (ammonia/ chlorine)
    - a. Typical exposures
    - b. Actions
    - c. Decontamination methods
    - d. Treatment
    - e. Transportation precautions
  - 3. Pesticides (carbamates/ organophosphates)
    - a. Typical exposures
    - b. Actions
    - c. Decontamination methods
    - d. Treatment
    - e. Transportation precautions
  - 4. Chemical asphyxiants (cyanide/ CO)
    - a. Typical exposures
    - b. Actions
    - c. Decontamination methods
    - d. Treatment
    - e. Transportation precautions
  - 5. Hydrocarbon solvents (xylene/ methlyene chloride)

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- a. Typical exposures
- b. Actions
- c. Decontamination methods
- d. Treatment
- e. Transportation precautions
- 6. Considerations for performing invasive procedures
  - a. Risk versus benefit
  - b. Patient need

## IV. Decontamination approaches

- A. Purpose of decontamination
  - 1. Reduce the patient's dosage of material
  - 2. Decrease threat of secondary contamination
  - 3. Reduce risk of rescuer injury
- B. Environmental considerations
  - 1. Major consideration If there are no life-threats
    - a. Prevent run off of material
  - 2. If there are life-threats, patient comes first
    - a. Environmental considerations last
- C. Methods of decontamination
  - 1. Dilution
    - a. Lavage with water
    - b. Water is universal decontamination solution.
    - c. Dilution decreases dose and action
    - d. Reduction of topical absorption
  - 2. Absorption
    - a. Use of pads to "blot" up the material
    - b. Towels to dry the patient after lavage
    - c. Usually a secondary method to lavage
    - d. Common for environmental clean up
  - 3. Neutralization
    - a. Almost never used in patient decontamination
    - b. Hazard of exothermic reactions
    - c. Time to determine neutralizing substance
    - d. Lavage usually dilutes and removes faster
    - e. More practical with equipment, etc.
  - 4. Disposal/ isolation
    - a. Removal of clothing
    - b. Removal of substances which contain substances
- D. Decontamination decision making
  - Field considerations
    - a. Flight of walking contaminated to rescuers -"fast break" event action required now
    - b. Conscious, contaminated people will "self rescue" by walking out of hot zone
    - c. Immediate decontamination often not avoidable
    - d. Speed of hazardous material team response
      - (1) Patients often can't wait that long
      - (2) Patients become impatient and leave
    - e. EMS gross decontamination and treatment
      - (1) All EMS needs gross decontamination capability
      - (2) EMS preparedness for quick decontamination

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- (3) Need for rapid EMS PPE
- (4) Need quick transport isolation methods
- 2. "Fast break" incident decision making
  - a. Critical patient unknown/ life-threatening material
    - (1) Decontamination and treatment simultaneous
    - (2) Remove clothing
    - (3) Treat life-threatening problems
    - (4) Lavage water universal decontamination solution
    - (5) Contain/ isolate patient
    - (6) Transport
  - b. Non-critical unknown/ life-threatening material
    - (1) More contemplative approach
    - (2) Decontamination and treatment simultaneous
    - (3) Remove clothing
    - (4) Treat life-threatening problems
    - (5) Lavage water universal decontamination solution
    - (6) Contain/ isolate patient
    - (7) Transport
  - c. Non-critical substance known
    - (1) Slower approach
    - (2) Environmental/ privacy considerations
    - (3) More thorough decontamination
    - (4) Clothing removal
    - (5) Thorough lavage/ wash
    - (6) Drying/ reclothing PRN
    - (7) Medical monitoring
    - (8) Patient isolation PRN
    - (9) Transport
- 3. Longer duration event decision making
  - a. Patients in hot zone non-ambulatory
    - (1) No rescue attempted
    - (2) Wait for hazardous material team
    - (3) Team will set up decontamination corridor
  - b. Team will not make entry until
    - (1) Medical monitoring of entry team
    - (2) Decontamination corridor established
  - c. Longer duration event
    - (1) Often 60 minutes for team deployment
    - (2) Set up time
  - d. Better opportunity for thorough decontamination
  - e. Better PPE
  - f. Less chance of secondary contamination
  - g. Better environmental protection
- When in doubt better grossly decontaminated and alive than perfectly decontaminated and dead
  - a. Deal with patient emergencies first
  - b. Have some type of chemical PPE
- E. Decontamination methods
  - Decontamination and PPE is ideally driven by the substance encountered
    - a. Sometimes unknown

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- 2. Decontamination solutions
  - a. Do not attempt to neutralize
  - b. Lavage with copious amounts of water
  - c. Water is the universal solution
  - d. Tincture of green soap used to improve wash
  - e. Isopropyl alcohol is used for some isocyanates
  - f. Vegetable oil is used for some water reactive substances
- 3. Remove the clothing
  - a. Also remove rings and jewelry
  - b. Shoes and socks
  - c. Cut off clothing PRN
- 4. Thorough wash and rinse
  - a. Allow fluid to drain away
  - b. Don't allow them to stay in the run-off
- 5. Rewash and rinse
  - a. Careful attention to difficult areas
  - b. Difficult decontamination areas
    - (1) Scalp/ hair
    - (2) Ears/ ear canals/ nostrils
    - (3) Axilla
    - (4) Finger nails
    - (5) Navel
    - (6) Groin/ buttocks/ genitalia
    - (7) Behind knees
    - (8) Between toes, toe nails
  - c. Post "field decontamination" all patients should be presumed to still have some degree of contamination
  - d. They must be handled accordingly
- 6. Rapid decontamination
  - a. Two step process described
  - b. For fast breaking event
- 7. Decontamination corridor eight step process
  - a. Entry point at hot end
  - b. Tool drop and outer glove removal
  - c. Surface contamination removed
  - d. SCBA doffed
  - e. Protective equipment doffed
  - f. Clothing doffed
  - g. Thorough wash/ dry
  - h. Medical evaluation
- V. Rescuer personal protective equipment/ transport protection
  - A. Levels of hazardous materials personal protection
    - 1. Level "A" protection
      - a. Highest level of personal protection
      - b. High degree of chemical break through time
      - c. Encapsulated suit
        - (1) Covers everything including SCBA
      - d. Impermeable
      - e. Sealed

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- f. Typically used by hazardous material team for entry into hot zone
- 2. Level "B" protection
  - a. Level of protection typically worn by decontamination team
    - (1) Decontamination wears one level below entry
  - b. Usually non-encapsulating protection
    - (1) SCBA worn outside suit
    - (2) Easier entry and SCBA bottle changes
  - c. Much easier to work in
  - d. High degree of repellence
- 3. Level "C" protection
  - a. Non-permeable clothing
  - b. Eye and hand protection
  - c. Foot covering
  - d. Used during transport of patients with potential of secondary contamination
- 4. Level "D" protection
  - a. Firefighter turnout clothing
- B. Determining appropriate PPE
  - 1. Ideally the chemical is known
  - 2. A permeability chart is consulted to determine "breakthrough" time
  - 3. Double or triple gloves are used or chemical resistant gloves
  - 4. Nitrile gloves have a high resistance to chemicals
  - 5. If situation is emergent
    - a. Take maximal barrier precautions
    - b. Full turnouts or Tvek suit/ gowns
    - c. Use HEPA filters and eye protection
    - d. Double or triple glove
    - e. Remove leather shoes, use rubber boots
  - 6. Ideally at least level "B" protection should be used
  - 7. Ideally use disposable protection
- C. Transportation of semi-decontaminated patients
  - 1. Use as much disposable equipment as possible
    - a. Reduces decontamination later
  - 2. Practicality of lining an ambulance interior with plastic
    - a. Impractical
    - b. Time consuming
    - c. If airborne contaminants can permeate cabinets it is unsafe for the driver to operate the ambulance
    - d. Better to isolate the patient
  - 3. Patient isolation
    - a. Stretcher decontamination pool
    - b. Continue decontamination and contain run-off
    - c. Plastic can be used to cover pool
    - d. Fits on stretcher
  - 4. Transport to facilities predetermined to handle hazardous materials
- VI. Medical monitoring and rehabilitation
  - A. Entry team/ decontamination team readiness prior to entry
    - 1. Assessment of vital signs and documentation
    - 2. Team members should have normal values on file
    - 3. Documentation flow sheet must be started

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- a. Blood pressure
- b. Pulse
- c. Respiratory rate
- d. Temperature
- e. Body weight
- f. ECG
- g. Mental/ neurologic status
- 4. Rescuer PPE can cause considerable heat stress
- 5. Prehydration prior to entry
  - . 8-16 ounces of water or sport drink
- B. After exit personnel should return to the medical sector for "rehab"
  - 1. Re-assessment of vital signs and documentation
  - 2. Documentation flow sheet must be started
    - a. Blood pressure
    - b. Pulse
    - c. Respiratory rate
    - d. Temperature
    - e. Body weight
    - f. ECG
    - g. Mental/ neurologic status
  - 3. Re-hydration at exit
    - a. 8-16 ounces of water or sport drink
  - 4. Use weight to estimate fluid losses
    - a. Medical control/ protocol determination
      - (1) PO fluids
      - (2) IV Fluids
  - 5. No re-entry until
    - a. Vitals back to normal
      - (1) Non-tachycardic
      - (2) Alert
      - (3) Normotensive
      - (4) Body weight within percentage of normal
- C. Heat stress factors
  - 1. Prehydration of member
  - 2. Degree of physical fitness
  - 3. Ambient air temperature
  - 4. Degree of activity and duration
  - 5. Rescue PPE
    - a. Suits protect but prevent cooling
    - b. There is no way to lose heat by
      - (1) Evaporation
      - (2) Conduction
      - (3) Convection
      - (4) Radiation
    - c. Like being in a sauna
- VII. Practice the following
  - A. Donning and doffing level B and C PPE
  - B. Set up a rapid 2 step decontamination process
  - C. Set up 8 step decontamination process

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Operations: 8

Hazardous Materials Incidents: 4

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- D. Give a simulated chemical determine PPE and decontamination methods
- E. Pre-entry medical monitoring and documentation
- F. Exit medical monitoring and documentation
- G. Preparing a patient and ambulance for transport